Electricity & Magnetism

FORMULAS

Coulomb's Law: $F = \dfrac{kq_1q_2}{r^2}$, $k = 9.0 \times 10^9\ ^{N\cdot m^2}/_{C^2}$

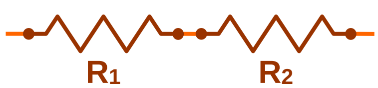
current: $I = \dfrac{q}{t}$

electric field intensity: $E = \dfrac{F}{q}$

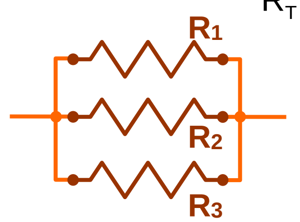
voltage: $V = \dfrac{W}{q}$

Ohm's Law: $V = IR$

resistors in series: $R_T = R_1 + R_2 + \cdots$



resistors in parallel: $\dfrac{1}{R_T} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3} + \cdots$



two resistors in parallel: $R_T = \dfrac{R_1R_2}{R_1 + R_2}$

n identical resistors in parallel: $R_T = \dfrac{R}{n}$

power: $P = VI$

transformers: $\dfrac{N_1}{N_2} = \dfrac{V_1}{V_2} = \dfrac{I_2}{I_1}$ and $P_{in} = P_{out}$ assuming no loss

force on a moving conductor in a magnetic field: $F = B_{\perp} \cdot I \cdot \ell = B \cdot \sin\theta \cdot I \cdot \ell$

force on a moving charge in a magnetic field: $F = q \cdot v \cdot B$

where…

B	=	magnetic field strength (T)	q	=	charge (C)
E	=	electric field strength ($^N/_s$)	R	=	resistance (Ω)
F	=	force (N)	r	=	charge separation (m)
I	=	current (A)	t	=	time (s)
ℓ	=	length of conductor (m)	V	=	voltage (V)
N	=	number of turns (-)	v	=	velocity ($^m/_s$)
n	=	number of resistors (-)	W	=	energy (J)
P	=	power (W)	θ	=	angle of incidence of field (°)

CONVERSION FACTORS

1 hp = 746 W

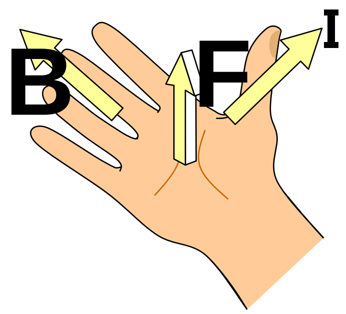
1 e (electronic charge) = 1.60×10^{-19} C

1 Tesla = 10,000 Gauss

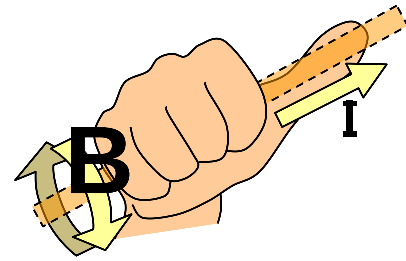
Authored by Gordon Wong

RIGHT HAND RULES

For Force from a Magnetic Field



For Magnetic Field Around a Wire

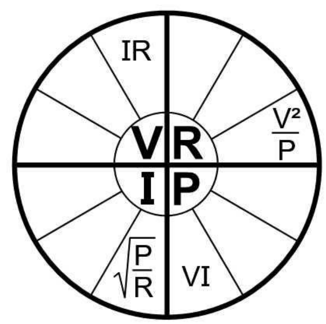


Point your fingers in the direction of the magnetic field (B) and your thumb in the direction of the current (I). The palm of your hand will push in the direction of force (F).

Point your thumb in the direction of the current moving through the wire (I). Your fingers will naturally wrap around the wire in the direction of the induced magnetic field (B).

EXERCISES

A. By using only Ohm's Law and the equation for power on the preceding pages, you can write expressions for voltage, resistance, current and power in terms of any two of the other three. (In other words, voltage can be calculated from I and P, I and R, or P and R, and so on.) Complete the wheel at right with these expressions.



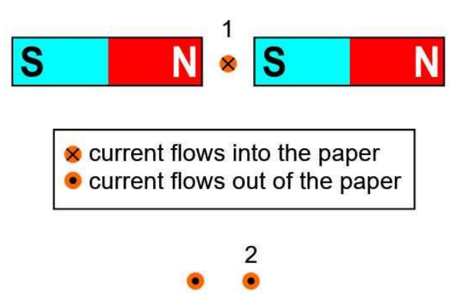
B. In order to disable a bomb, you must reduce the resistance of a 680-Ω resistor to 100 Ω within 5 minutes. How will you do it? [*Hint: Perhaps you could add something to the bomb?*]

C. The secondary of an ideal transformer has 120 times as many turns as the primary, which is hooked up to a 120-V circuit. The current in the secondary is 25 mA. Determine:

1) the secondary voltage
2) the primary current

D. In the diagrams at the right, using the appropriate right hand rule, determine the direction of force acting on

1) conductor #1
2) conductor #2



SOLUTIONS

A. Do it yourself. ;-)
B. Connect a 117-Ω resistor in parallel with the 680-Ω resistor. Did you make it?
C. (1) 14.4 kV (2) 3.0 A D. (1) down the page (2) left